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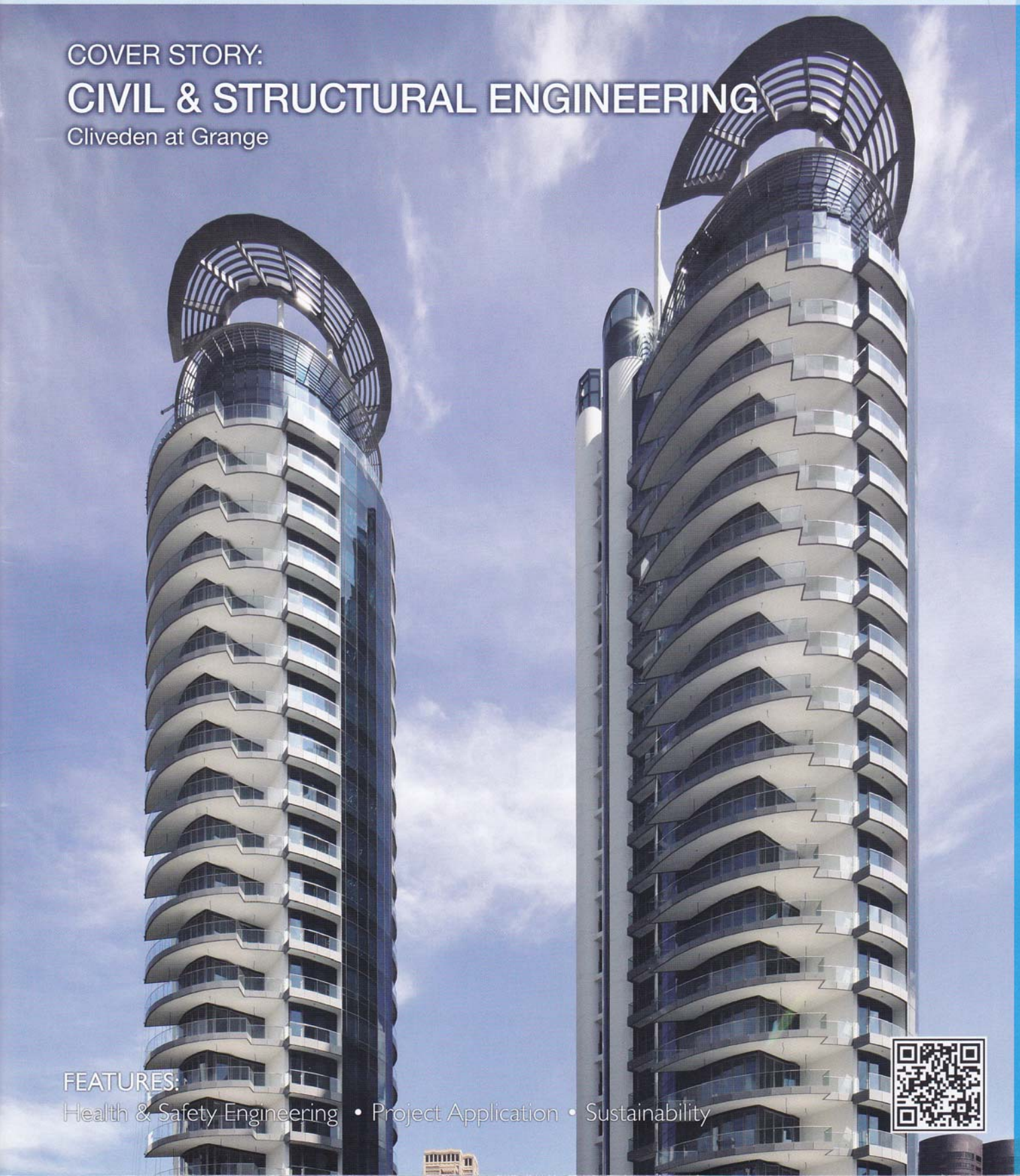
# THE SINGAPORE ENGINEER



COVER STORY:

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# Ergonomics at the construction sites

by Dr N Krishnamurthy, Safety Consultant and Trainer, Singapore

The right working conditions should be created, in order to prevent workers from suffering pain and injury.

## INTRODUCTION

*Dr N Krishnamurthy*

Most fatalities and injuries at construction sites can be traced to the worker not working in a safe position, using the wrong tool for the job, or using the right tool the wrong way. Workers are provided Personal Protective Equipment (PPE) of various types for different hazardous tasks, but inadequate understanding and unsafe conditions result in workers adopting wrong work postures. The article discusses the contributing factors to workplace ergonomic problems in relation to Singapore's Workplace Safety and Health Act of 2006; identification, assessment and management of Work-related Musculo-Skeletal Disorders (WMSDs); the benefits of a pro-active approach to ergonomics planning; and feasible solutions. Examples and case studies of ergonomic improvements in construction engineering, and safety gear are presented. The focus is on construction workplace ergonomic issues such as manual handling, and consequences of PPE misuse.

## ERGONOMICS

The word 'ergonomics' is derived from two Greek words - 'ergon', meaning work, and 'nomos', meaning natural laws. Today, the word is used to describe the science of 'designing the job to fit the worker, not forcing the worker to fit the job - thus the science of adapting work and working conditions to suit the worker', according to Rwamamara and Smallwood (Ref 1), whose comments on ergonomic problems and solution recommendations in industrially developing countries are cited frequently in this article.

Employees' abilities to perform physical tasks may depend on age, physical condition, strength, gender, stature etc. The science of ergonomics examines how to improve the fit between physical demands of the workplace and employees who perform the work, or in other words, how to protect the workers from strain.

Effective and successful fitting of the workplace conditions to the capabilities of the workforce assures high productivity, avoidance of illness and injury risks, and increased satisfaction among the workforce. Although the scope of ergonomics is much broader, the term here refers to assessing those work-related factors that may pose a risk of Musculo-Skeletal Disorders (MSDs) and recommendations to alleviate them.

Common examples of ergonomic risk factors are found in jobs requiring repetitive, forceful, or prolonged exertions of the hands; frequent or heavy lifting, pushing, pulling, or carrying of heavy objects; and prolonged awkward postures. Vibration and excessive heat or cold may also add risk to these work conditions. The level of risk depends on the intensity, frequency, and duration of the exposure to these conditions.

Ergonomic problems may also be culture- and technology-related. For instance, repetitive movements are more likely in a country which makes predominant use of masonry materials for walls, than in a country that makes use of prefabricated framing and panels such as the USA, and recently Singapore. Climbing and descending are more likely problems in a country which makes limited use, if any, of vertical transportation of people with the help of personnel hoists, than in a country that does. Presently, squatting on the floor or ground for many hours may not be a problem in many Asian countries, but modern youth may not retain such habits for long.

## CONSTRUCTION ERGONOMICS

Construction, by its very nature, is a problem for ergonomists, as it requires work above shoulder level and below knee height. Materials may also be heavy and/or inconveniently sized and shaped, thus presenting manual material handling problems.

Numerous construction tasks pose significant risks to workers. To eliminate or mitigate the risks, it would be necessary to identify work risks in construction and assess the impact of even minimal ergonomics on the construction process.

The most important safety-, health-, and ergonomics- related problems involving construction tools, leading to construction accidents, have been identified as follows:

- Manual handling, lifting, and carrying
- Tripping and falling
- Noise
- Vibration
- Dust exposure
- Poor design of tool interfaces

Of the job factors which caused major ergonomics-related problems, the following were assessed in a 2003 US study, to be the top four:

- Bending or twisting the back
- Staying in the same position for long periods
- Working in the same position for long periods
- Handling heavy materials or equipment

Certain problems peculiar to Asian (and certain African nations) may be highlighted, in addition to bending and twisting of the body:

- Reaching away from the body and reaching overhead
- Working in awkward positions
- Lifting and manually handling heavy and irregularly sized and shaped materials and components

- Working below knee level
- Working while kneeling

A study of non-traumatic injuries in India indicated the predominance of repetitive movements, followed by awkward postures, heavy lifting, and lack of breaks.

## MAGNITUDE OF THE PROBLEM

According to Wellsphere (Ref 2), Dr J D Miller, retired Director of National Institute for Occupational Safety and Health (NIOSH), USA, said "that by any epidemiological criteria, occupational musculo-skeletal injures represent a pandemic problem in the United States with gigantic effects on the quality of millions of peoples' lives every year".

The US Bureau of Labor Statistics reports that MSDs amounted to 56% of all occupational illnesses in 1991 and continued to increase. Though cost estimates vary greatly, medical and workers' compensation costs for these disorders may exceed US$ 100 billion annually. All over the world, the construction industry is worst hit with accidents and fatalities. Among accidents, ergonomics is a leading cause.

CPWR (Ref 3) provides copious statistics on American construction ergonomics. Figure 1 shows non-fatal injuries and illnesses with days away from work, in the US construction industry, in 2005. It highlights that ergonomic problems such as sprains and strains (dominated by back pain and herniated disc) are the most common.

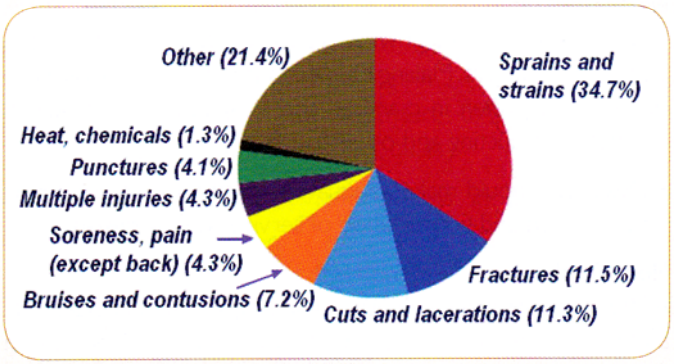


*Figure 1: Non-fatal injuries and illnesses.*

Figure 2 shows risk factors for work-related MSDs with days away from work, in the US construction industry, in 2005, indicating that common causes for work-related MSDs are bending, twisting, and over-exertion.

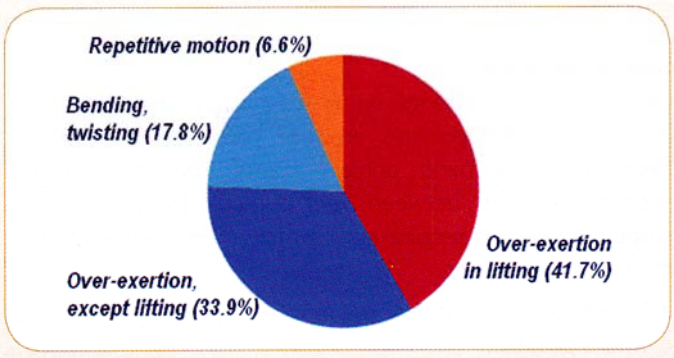


*Fig. 2. Risk factors for work-related MSDs.*

Figure 3 clearly shows that next to transportation, the rate of back injuries and illnesses with days away from work is highest in construction.

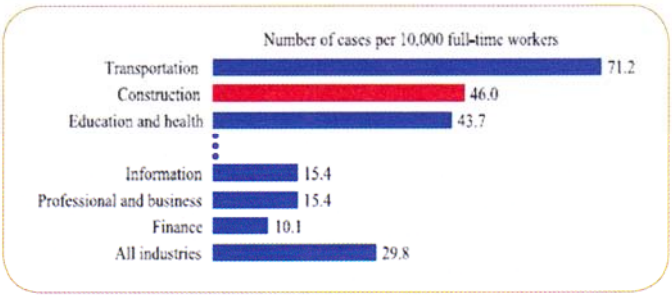


*Figure 3: Rate of back injuries and illnesses, 2005.*

## ERGONOMICS IN SPECIFIC CONSTRUCTION TRADES

Ergonomic hazards of common trades in construction and some solutions (shown as bullet points) are as follows:

### Concreting

Shovelling and smoothing the surface of concrete are strenuous on the lower back. Vibration of cast concrete can have cumulative deleterious effects on the human system.

Concrete uses cement and this usually involves moving cement bags, which often weigh 50 kg. This problem is discussed in detail elsewhere in the article.

- The addition of plasticisers improves concrete workability.
- Singapore and other countries still using larger than 25 kg loads must proactively reduce the loads or provide human or mechanical aids.
- Vibration cushioning gloves should be used and such tasks should be rotated among the workers.

### Reinforcement

The fixing and tying of reinforcement bars require bending and a great deal of rapid repetitive twisting of the wrist, the latter resulting in the development of ganglion cysts. Most on-site rebar binding with wire is done in a squatting position in many Asian countries including Singapore (Figure 4, left). Although one may consider this as culturally acceptable, especially since the immigrant labour originates from under-developed countries, it still is an adverse practice, ergonomically.

- Even if one does not go to the extent of providing mechanical aids to do binding from a standing position, as in Western countries (Figure 4, right), employers should try to provide relief by job rotation, rest periods and so on.

*Figure 4: Binding re-bars with wire. The image on left shows a worker binding bars while in a squatting position while the image on right shows a worker standing and performing the task with the help of a mechanical aid.*

Steel is heavy. A 15 m long, 32 mm diameter bar will weigh 95 kg and it is not unusual to see two workers carry it. If done on a regular basis, this would be an invitation to MSDs.

- More workers may not always help because of the uneven distribution of the continuous load on a number of workers of unequal height (and enthusiasm!) Mechanical aids are a must in this context.
- The use of fabric, in lieu of bar reinforcement, reduces the amount of time spent fixing and tying reinforcement for each concrete element, and reduces the amount of bending and rapid repetitive twisting of the wrist.
- Using trestles also enables steel fixers to fix cages at 'worktop' level.

**Formwork**

The erection and striking of falsework (support structure) and formwork require large amounts of bending, twisting, and use of body force.

- Designers can facilitate the use of composite systems through the simplification of design, table forms, and wall forms which can be handled by craneage, thereby reducing the manual aspect of the activity.
- The use of precast concrete also reduces the amount of falsework and formwork as well as on-site fixing and tying of reinforcement required. Prestressed concrete elements, particularly slabs, also reduce the amount of reinforcement bars.

**Structural steelwork**

Problems with steel erection include awkward postures, occasional high force requirements, static postures, repetitive movements, use of pneumatic tools, and lifting. The high risk nature of the activity which entails straddling beams several metres in the air while aligning and bolting them to columns compounds the problems.

- Pre-assembly, simple joints, and integral safety features can reduce hazards.

**Masonry**

Block- and brick- laying represent major work hazards in building. Lifting an average of 1000 bricks a day is equivalent to lifting 2300 kg to 4000 kg, and 1000 trunk-twist flexions.

- A suitable intervention may be provision of waist-high material platforms.
- Design improvements include the incorporation of hand-holds in blocks to facilitate lifting.
- Alternative wall systems such as drywalls constitute the optimum solution.

**Roofing**

Roofing poses many different hazards due to minimal ergonomic input, but the prime one is material handling. Of the three types of roofing (unit and sheet materials and waterproofing membranes), unit materials require considerably more bending, twisting, and handling of mass per square metre of covered area, than sheet materials.

- Use of 'ladder type' tile lifts facilitates the lifting of unit materials to roof level.

**Building facades**

Differing systems and materials pose differing problems. Concrete surface finishes such as bush-hammering present a risk of hand-arm vibration and health problems such as silicosis. Natural stone claddings require a lot of lifting and hoisting of heavy panels as well as adopting of awkward postures and hand-arm vibration as a result of fixing. These present a risk of back injury and hand/wrist problems.

- Design alternatives include light-weight sheet metal claddings and prefabricated, unitised curtain walling, which will minimise the risk factors.

**Plumbing and drainage/pipe-fitting**

Piping is often laid at odd angles and in cramped spaces. Specific piping materials have specific jointing methods, not all of which are complementary to basic ergonomic principles. A number of installations are suspended and require extensive overhead work. The fixing of the suspension hangers results in substantial stretching and twisting, and consequently a high level of stress on the neck and shoulders of workers.

- Designers should consider the ergonomic implications of jointing methods when specifying materials, the feasibility of prefabricated stacks, and horizontal and vertical service ducts for piping.

**Electrical work**

Electricians often work in cramped postures and their work entails a large amount of wrist action, resulting in stress on the arms and shoulders. Making connections requires extensive use of hand-tools, often in cramped spaces such as ceilings above and between ducting and other piping.

- Designers should make adequate provision for access during both design and coordination of services during design.

**Floor finishes**

All floor finishes require constant kneeling and bending. Ceramic and similar tile and terrazzo work entail additional risk. Often the weight of the tiles to be set can be substantial, particularly in the case of natural stone. Terrazzo and similar finishes require considerable hand and wrist motion.

- When specifying finishes, designers should consider the nature of the pertaining processes.
- Using trestle type work benches reduces the need for tilers to cut at floor level.

**Suspended ceilings**

Most suspended ceilings require significant overhead work although the components are not particularly heavy. It is necessary to suspend primary tracks from hangers and secondary tracks between the primary tracks. Screw-up suspended ceilings require considerably more overhead work than lay-in tile ceilings.

- Consequently, designers should specify lay-in tile ceilings where possible.

- The use of mobile tower scaffolds with full work platforms is more complementary to ergonomics than the use of ladders.

**Painting and decorating**

Overhead painting of ceilings places considerable stress on the arms and shoulders, as well as the neck.

- Designers should consider self-finishes where possible.

**Paving and other external work**

Brick paving requires work similar to that of tiling. In addition, pavers often have to be cut with an electrically powered masonry saw which requires working at ground level, and consequently requires the workers to bend a great deal.

- The use of work-bench type masonry saws does reduce the hazard. Although asphalt paving exposes workers to whole-body and hand-arm vibration, workers are not exposed to the volume of repetitive movements and other work-related postures as in the case of brick paving.

## CAUSES AND IMPACTS

Environmental factors associated with the workplace can cause many workplace problems. Below are some examples:

- Extreme high temperatures can increase fatigue rate.
- Exposure of hands and feet to cold can decrease blood flow, muscle strength etc.
- Excessive or awkward grip force for tool handles or objects can cause injuries.
- Exhaust cold or hot air directly from tools or equipment can cause discomfort.
- Inadequate or too bright lighting in a workplace causes employees to assume awkward postures to accomplish work tasks, resulting in a loss of product quality.

Other sources of ergonomic problems in a construction project are:

1. Contractor's awareness of ergonomics
2. Standard of site house-keeping
3. Degree of planning by contractor
4. Amount of work during project
5. Degree of mechanisation
6. Format of materials
7. Specifications
8. Details
9. Type of procurement system
10. General design

Rwamamara and Smallwood (Ref 1) list the impact of ergonomics on various stages of a building construction project, as shown below, in decreasing order of importance:

1. Structural steel structure
2. Reinforced concrete structure
3. Installation of services (structure)
4. Roof
5. External works
6. Ceilings
7. Cladding/external fabric
8. Site clearance and earthworks
9. Finishes
10. Walling/partitions

## MANUAL HANDLING

**The problem**

Almost all construction activities involve lifting and shifting objects by hand, which can lead to many ergonomic problems, mostly MSDs, causing considerable human misery and costing massive amounts of money for compensation and cure. Manual handling thus rates a special focus.

More than a third of all over-three-day injuries reported each year to the Health and Safety Executive (HSE) and local authorities, in the UK, are caused by manual handling - the transporting or supporting of loads by hand or by bodily force. The pie chart (Figure 5) from HSE (Ref 4), shows the pattern for over-three-day injuries reported in 2001/2002. In the US, over-exertion, when lifting, caused 42% of the WMSDs with days away from work in construction as already shown in Figure 2.

This is the single most vexing and most costly deficiency in worksites, although many nations might not have identified it or addressed it as such.

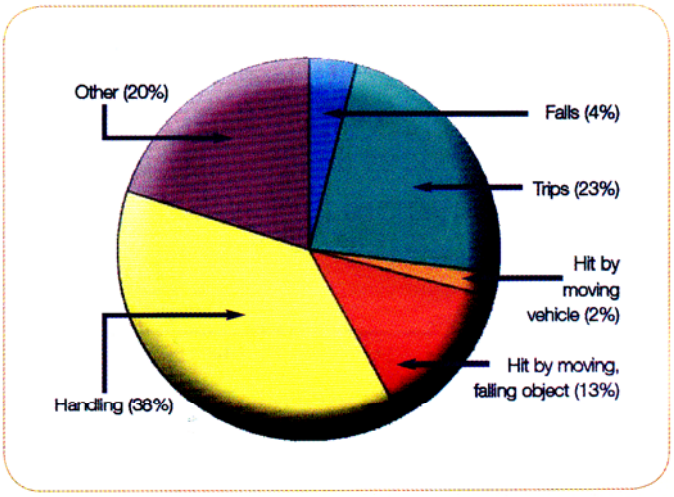


*Figure 5: Accidents causing over-three-day injuries.*

The biomechanics of manual lifting is very simple but worrisome. The simple fact is that when a person bends down and picks up 1 kg, his vertebral column (backbone) experiences a compression force of 10 kg to 15 kg [Figure 6 (Ref 5)].

It may be shown from principles of simple mechanics that, allowing for the pressure from the weight of the person's torso, the limit for the weight that an Asian male can bend and lift routinely is slightly less than 25 kg. Canada recommends 23 kg as the limit (Ref 6). Lifting anything larger than that, except occasionally, will affect the spine adversely, leading to chronic back pain and irreversible damage. In the construction industry, workers often carry routinely much more than 25 kg.

The problem does not end there. While 25 kg may be the upper load limit for normal carrying of a load straight up and down in front, any twisting of the torso with respect to the hips worsens the stress on the backbone and reduces the safe weight that can be carried. For instance, rotating the body 45° can reduce the carrying limit by about 15%.

Frequent lifting and carrying of 50 kg cement bags will lead to permanent spinal injuries. Only some countries like Australia and UK have mandated worker maximum loads to 20 kg to 25 kg.

Singapore has recommended that worker loads be limited to 25 kg, in CP92 (replaced with SS 569), BOWEC, Construction Regulations (Jan 2008) etc. The limit is mentioned as desirable in risk control for hazardous industries, and in design for safety, DO2RAS, CONQUAS, and other documents issued by authorities.

But in the present safety culture context, many simply do not know that there are guidelines on this topic, and even those who know may not adopt the recommendations because they are not mandatory.

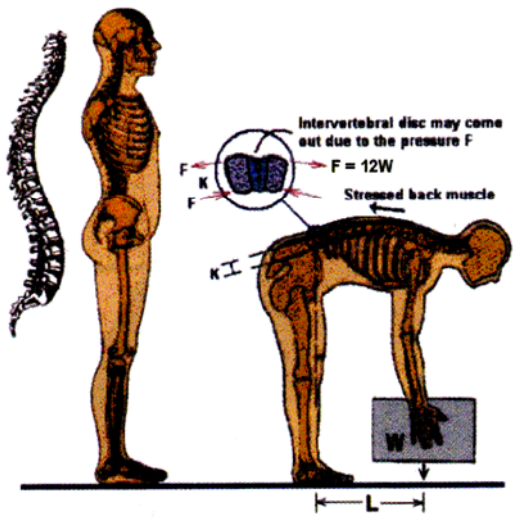


*Figure 6: Forces on the vertebral column..*

**The solution right now**

1. Highlighting existing guidelines through publicity materials, advisories etc. WSHC (Workplace Safety and Health Council) and MOM (Ministry of Manpower) have recently been doing a lot in this regard.

2. Educating stakeholders on the real dangers to workers handling heavy loads, and how in the long run, they can affect the health of workers. This means:

   (a) Educating the worker on why he should not carry heavy loads.

   (b) Educating the supervisor on how and why he should watch out for workers impulsively handling heavy loads.

   - Safety officers and supervisors must avoid this risk, through (i) imparting training for proper lifting, and (ii) adopting mechanical assist devices.

   (c) Educating the management so that it understands that adverse impact on workers can reduce productivity and cause a lot of compensation claims and court cases, thereby affecting business.

   (d) Educating inspectors on what to watch out for, and how to deal with violations.

   (e) Educating the public so that it does not expect or allow workers to carry heavy loads, and will be on the lookout for, and report, violations of these guidelines.

3. Doing what can be done at workplaces, within the existing system, to alleviate the problem. Trying the standard hierarchy of controls put forward by Krishnamurthy (Ref 7), as shown below:

   (a) Elimination: Just not letting people handle loads. Using mechanical aids to move everything, if more than, say, 5 kg. This may not be easy.

   (b) Substitution: Substituting with loads smaller than 25 kg. Either getting smaller weight packages, absorbing the extra cost as insurance against health impacts, or, breaking up the larger loads delivered to site into smaller packages for shifting.

   (c) Engineering Controls: Providing mechanical aids operated by the workers, to ease their load, such as push carts, lever grips, hand-operated dollies, etc. The author once proposed a simple, low-cost swing arm mechanical device, to eliminate repetitive twisting by the worker, by letting the device do the twisting, leaving the worker to do only the pushing, as in Figure 7 (Ref 5).

   (d) Administrative Controls: With low wages being paid, immigrant construction labour is cheap. The simple expedient of putting two people to carry loads from 25 kg to 50 kg, and proportionately more workers for heavier loads, will be adequate in the short term. This will require a little more supervision, and a little smarter management to ensure that the workers share the load nearly equally.

   (e) PPE: Although PPE will not reduce the load, gloves and safety shoes will protect hands and feet in gripping the load and if the load should fall.

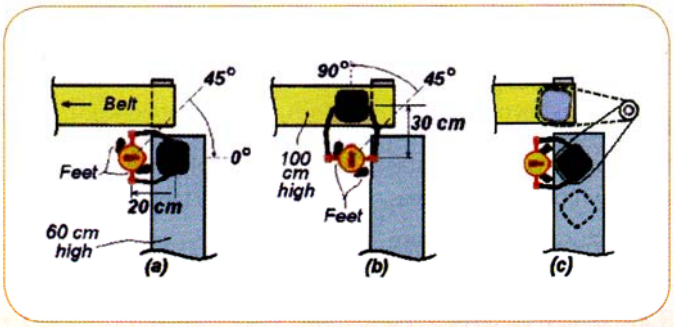


*Figure 7: Case study of an ergonomic intervention.*

## PROCEDURE FOR ERGONOMICS MANAGEMENT

### Basic steps

A formal procedure for ergonomics management has been described in detail by Cohen et al (Ref 8). The basic steps are:

1. Looking for Signs of Work-related MSD Problems
2. Setting the Stage for Action
3. Training and Building in-house expertise
4. Gathering/Examining WMSD Evidence
5. Developing Controls
6. Health Care Management
7. Proactive ergonomics

While the first six steps are straight-forward and more in the nature of administrative procedures and controls, the last, proactive ergonomics, deserves special emphasis.

### The proactive approach

- Proactive programmes focus on prevention of WMSDs and other ergonomic risks by identifying, assessing, and controlling risk factors at the planning stage.
- Design steps should ensure proper selection and use of:
  - Equipment and tools
  - Job methods
  - Workstation layouts
  - Materials
- Risks should be addressed at source.
- The decision must be made on which functions should be handled by machines and which by people.
- The decision must be made on which task can be accomplished by whom, particularly avoiding strenuous tasks with loads that are too large, too heavy, placed too high etc.
- Questions must be asked before anything harmful happens:
  - Are employees working in uncomfortable postures?
  - Do they show signs of fatigue and discomfort?
  - Are there other warning signs such as reports of problems, high levels of absenteeism etc?
  - Do employees have ideas about how to improve products and make their jobs less physically demanding and more efficient, and apply them?

### Benefits of proactive action

- Reduced absenteeism
- Increased efficiency and productivity
- Improved quality
- Decreased fatigue
- Improved employee morale
- Increased cost savings within short payback periods from:
  - Greater output over a given time period
  - Reduced wastage of raw materials
  - Higher quality output and fewer mistakes
  - Savings in wage costs from jobs which were made less manually intensive
  - Reduced future compensation claims and recruitment

## PPE AND ERGONOMICS

PPE and ergonomics are closely related because the way a worker wears and uses his PPE will have a large influence on his comfort and well-being. The following are a few instances:

1. The wrong size of, or wrongly worn ear-plugs, which are meant to alleviate workplace noise problems, may cause earache and infection.
2. Helmet straps and chin straps, badly adjusted, may give a head/neck ache. Loose-fitting helmets will expose the worker to injury.
3. If gloves are not worn, due to a lack of insistence by the supervisor, it will lead to damage of hands.
4. Loosely worn full-body safety harnesses may damage the genitals of wearers. The use of body harnesses without appropriate anchors, falling clearance, and rescue system, will expose the worker to greater danger than without such PPE.

## BENEFITS OF ERGONOMIC SOLUTIONS

According to MacLeod (Ref 9), among the numerous benefits of ergonomic solutions, the ones that directly favour the economics, are as follows:

1. Dramatic reductions in workers' compensation costs
2. Improved productivity
3. Fewer mistakes and less scrap
4. Improved efficiency with better working posture
5. Improved efficiency with less exertion
6. Improved efficiency with fewer motions
7. Improved efficiency with better heights and reaches
8. Less fatigue
9. Reduced maintenance downtime
10. Protecting human resources
11. Identifying waste
12. Fresh insights on the operations
13. Offsetting the limitations of an ageing workforce
14. Reduced turnover
15. Reduced absenteeism
16. Improved morale
17. Promoting employee involvement
18. Improved labour relations
19. Revival of basic 'Methods Engineering'
20. Ability to optimise the Lean (Toyota) Process
21. Ability to make things more human compatible, and improve the human-system interface

## THE SINGAPORE SCENE

As per published statistics, construction ergonomics is not at all a problem in Singapore. Over the last few years, no injuries were reported under the category of MSDs, which has an incident rate of less than 1% of all occupational diseases.

Having personally watched workers lift and move heavy construction materials and components around, the author attributes the low reported incident rate to the following, supported by some of the comments in Ref 10:

- Under-reporting by the victims, and by employers themselves, since these ergonomic problems seem much less severe in comparison with most other construction accidents, although the relatively low grade pain could get worse over the long-term.
- The under-reporting by the victims could be because the tolerance level of workplace discomfort and/or pain is relatively higher in Asia than in the West, especially since the immigrant workers who come to Singapore are from the relatively less developed countries.
- Further, as noticed in Australia (Ref 10), since even most local and educated workers do not report body aches and pains, immigrant workers, who are dependent on the employer and the system for their work permits, would, all the more, tend to ignore and suppress their pain as much as possible.
- Under-reporting by the employers could be mainly because they really did not realise the long-term implications of MSDs and manual handling, and partly because they too did not take seriously 'minor' problems that would adversely affect productivity.
- MSDs and back pain symptoms grow gradually and slowly, taking a year or more to become unbearable even for young workers. Since immigrant workers are sent back home in about two years, there is little or no follow up of their health in this regard.
- The metrics used for recognising ergonomic problems may involve only voluntarily reported and hospitalised cases, and are not based on regular personal interviews and check-ups conducted on the workers.

Most of the preceding explanations place the burden of proof and cure for poor ergonomics squarely on the shoulders of the managements. Fortunately, as has been indicated in this article, the controls are very simple and inexpensive, compared to vexing problems like working at height.

At the same time, going beyond construction ergonomics, a casual survey of world statistics on ergonomics (Ref 10) indicated the following:

Australia: In a 2002 study of 60 people working at a Sydney call centre, it was found that although only two or three people officially reported Occupational Overuse Syndrome, up to 70% claimed to have aches and pains.

According to Mr Bill Mountford, Chief Executive, Victorian WorkCover Authority, Victoria, Australia:

- Each year, for the past five years, between 17,000 and 18,000 Victorians were injured at work via a sprain, strain or back injury.
- While many Victorians mistakenly believe that muscular and soft tissue injuries are not serious, anyone who has suffered from chronic back pain or an injury of this kind knows just how debilitating the injury and recovery period can be.
- The impact on a person's quality of life and that of the person's family can often be as devastating as the injury itself.

USA: The Occupational Health and Safety Administration (OHSA) estimates that, every year, work-related (ergonomic) reasons account for more than 647,000 injuries and illnesses which, in turn, account for more than one-third of workers' compensation costs - an estimated US$ 15 bilion to US$ 20 billion in direct worker's compensation costs in 1995 and an additional US$ 45 billion to US$ 60 billion in indirect costs.

UK: Around 1.1 million people in Great Britain suffered from MSDs caused or made worse by work, in 2001/2002.

Singapore: The republic has also recognised the incidence of ergonomic problems and has taken steps to address them. Seven in 10 adults in Singapore suffer from some form of work-related aches or pains, usually from improper posture during computer usage, according to a 2004 survey done by Singapore General Hospital (Ref 11). The body parts with the highest reported pain were neck (46%), shoulder (42%) and lower back (42%). MSDs are more common in females (79%) compared to males (64%).

SS 514 Code of Practice for Office Ergonomics, published by SPRING Singapore in 2005 (Ref 12) offers practical tips for companies. MOM has issued comprehensive guidelines on Work in Standing/Sitting Positions (Ref 13). The Ergonomics Society of Singapore promotes good ergonomics.

Although not addressing ergonomics specifically, broadly speaking, the Singapore Ministry of Manpower Workplace Safety and Health Act of 2006 has been quite proactive, stating as follows:

- The employer is responsible for the health and safety of workers.
- Accountability for accidents and illnesses at the workplace spreads over all stakeholders and they face heavy penalties.
- The employer must do everything 'reasonably practicable' to protect workers from harm. The employer must put funds, equipment, staff and materials to best use, conforming to best practices.
- The employer must conduct risk assessment and implement controls for all hazardous jobs.

- The employer must keep records for three years, meaning causes of worker strain and long-term injury may be tracked back to poor ergonomics at the workplace.
- The employer must reduce risk at source, that is, before the worker starts doing the assigned task, so that it does not affect him.

## CONCLUSION

Proactive Singapore will be doing well by focussing on ergonomic problems in construction, before they escalate into a national safety and legal problem. The problems and solutions to eliminate or alleviate their effects are well-known and implementation framework well established. All that is needed is concerted action along the lines of the recent approach to noise-induced deafness.

- Knowledge on long-term effects of poor ergonomics should be disseminated more extensively to the industry, workers and other stakeholders.
- The metrics for ergonomic statistics should be reviewed and redefined.
- The necessary medical checks and controls should be implemented, including firm enforcement of regulations and codes, especially on manual handling.

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## Singapore Standard on manual handling

Launched in 2012, Singapore Standards - SS 569: 2011 on the Code of Practice for Manual Handling, seeks to improve safety and health as well as help reduce the number of injuries at the workplace. This standard is a revision of the Codes of Practice, CP 92.

Manual handling is an essential activity in most workplaces. Musculoskeletal injuries and disorders, most commonly associated with manual handling, may be avoided by implementing the SS 569.

The SS 569 covers the identification and risk assessment of manual handling hazards as well as helps to put in place appropriate risk control measures. It also provides guidance on the planning and implementation of an ergonomics programme for manual handling operations. In the SS 569, the risk assessment checklist has been updated and expanded to include the latest practices in helping workers avoid injuries arising from manual handling activities.